

Report of
Panel

1

Long Range Plan

National Library of Medicine

Building and Organizing The Library's Collection



U.S. Department of Health and Human Services
Public Health Service
National Institutes of Health

Building and Organizing The Library's Collection

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Background and Context

Context

The assignment to this Panel was given in the context both of NLM's (National Library of Medicine) own historical development and of the changes that are occurring more generally in the transition of the United States into a social and economic structure increasingly based upon "information." The specifics of NLM's own programmatic needs will be extensively reviewed in the following sections, but it is valuable to see them in the context of the larger frame of reference.

Information in the U.S. Society and Economy

The effects of information technology and the increasing proportion of the national work force engaged in information work have been the focus of concern. "Information policy issues" of interest include: interaction between the public and private sectors; the best means for increasing the availability of information to the public; the effects of government policy upon that availability; the relationship between national productivity and the use of information as a resource in society; and the recognition that cognitive, information-based products and services are as significant to national productivity as physical goods and services.

Part of the general concern results from the complex interaction between modern communications and computer technology in the delivery of information resources. Consequently, there is a strong tendency to focus on the technologies rather than the information. As a result, though, the concentration of concern on the technologies, as such, has meant there has been no clear attention to the institutions of society, including libraries, by which those technologies become effective. Finally, there is an emphasis on

the industrial and commercial aspects of information, with correspondingly less attention paid to the roles and needs of the academic and professional communities.

But the biomedical enterprise, in particular, depends upon the ready availability of information resources of all kinds—people (such as the faculties of schools of medicine), biomedical libraries, computer facilities, audiovisual media and related facilities, and laboratories. And these information resources are used in biomedicine for a variety of purposes and in a variety of ways—in research, teaching, practice, management of hospitals and other medical facilities, and health policy planning and formulation. The current studies of the relative importance of cognitive versus procedural services in medical practice highlight their significance.

Until recently, biomedical information resources have been relatively stable, well defined, and reasonably well organized. Researchers and practitioners have had well-established patterns and expectations about their availability and use. Universities in particular have created libraries, computing centers, and similar administrative units to manage them. While there have been problems and issues of concern within individual institutions, until recently they represented simply the usual ones of management in a complex enterprise.

The changes in that previously stable, well-defined situation are dramatic, and they have immense effect upon both the organization of the university and the patterns for use of information resources in scholarship, research, and instruction. Fundamental changes are affecting the ways in which information is created, produced, organized, made available, protected, preserved, and used. They are affecting the ways in which scholars work, the methods of publication, and the means for distribution and access. Currently, faculty are forced to deal with these case by case, in an *ad hoc* fashion. But as new forms of information resources become increasingly important to both instruction and research, more formalized means of managing them will be needed. As a result, they are affecting the organization of the university and the libraries, computing facilities, and other information agencies within it.

It was these changes that led to the conception of a new kind of structure for dealing with the broad range of information resources needed in medicine and the initiation of programs for development of the IAIMS (Integrated Academic Information Management Systems) Project of the NLM, an outgrowth of an NLM-supported study of these changes.

The New Information Infrastructure

In its own planning for the future, NLM must define its role in recognition of the new information infrastructure feasible in this electronic environment. Powerful communications technologies and international networks now permit the development of a coordinated, distributed “library of record” that comprises the set of research collections throughout the country, each assuming archival and service responsibilities for selected portions of the literature. Such a distributed system represents a realistic response to the publication explosion and spreads the operational responsibility across a spectrum of institutions. In that way, for users located throughout the Nation, distributed collections provide service enhancements not possible in a centralized system. The role of NLM then becomes twofold in such a system—it is both a coordinator and a library of record in its domain of responsibility.

The new technologies permit (and indeed require) such a new information infrastructure, with compatible hardware, software, and network gateways on an international scale. Only in this way can the linkages be made to both traditional materials and new electronic ones to meet the needs of the medical community. In conceptualizing the expanded role of NLM, information should be viewed as a function as well as a set of formats, and user services should be designed with powerful capabilities for computing and communicating. Ready access to vital information resources and services, regardless of format or location, should become the objective of NLM.

Electronic Media

Perhaps the most fundamental changes are occurring in the patterns of distribution of information. In the 17th century, the scholarly journal came into being as a result of a then-new technology—the printing press. The journal article replaced personal correspondence with general distribution and thus served the same function as the town crier in announcing recent scientific discoveries. Today, in many fields, we are supplementing journal articles with electronic memoranda stored online for ready access. Tomorrow, these means for online communication may become the equivalent of the journal article as a means to document information that is in regular use by scientists.

Indeed, in an increasing number of circumstances, information no longer appears only in standard formats—i.e., as text in books, journals, or reports in either printed or electronic form—but instead is available as computer-based raw text, numerical, and even graphic files. The Census Report, the HSDB (Hazardous Substance Data Bank) of NLM, the CIS (Chemical Information System) of the Environmental Protection Agency, the National Health and Nutrition Surveys, epidemiology data, and GenBank, a collection of nucleic acid sequences sponsored by the National Institutes of Health, are available as computer data bases.

In the future, new technologies for optical and magnetic storage and quick retrieval of huge amounts of text at low cost will almost certainly generate new types of publications. While currently there are very few electronic journals and even fewer that are not counterparts of the printed forms, this situation is rapidly changing, and the expectation is that numerous journals may be made available online and as CD-ROM (compact disk-read-only memory) publications.

Overview

It was in this context, then, that the Panel considered the needs for NLM to plan the future and organization of its collection. The following sections of this report provide statements on which there was a consensus of views in the Panel with respect to three major areas. The discussion moves from a review of the overall mission of NLM, with emphasis on its historical development, to an extrapolation of that historical perspective into the future, to the detailing of major goals and objectives, and finally, to a set of specific recommendations.

The development of NLM's mission is seen as a continuum from the past into the future. It is based on the history of NLM, the legislative mandate under which the Library currently operates, and a manifesto for the coming decades. In that continuum over time, NLM is seen as a vital force in the historical development of the Nation's biomedical information system. Its role is represented by its own collection, by its service as the focal point for the national infrastructure, by its continuing effort to foster professionalism, and by its stimulation of technological advance. The users, their nature, and their needs are considered with specific reference to the role of collection development policies and creation of organizational tools that will assure that those needs continue to be met. International responsibilities of NLM are seen as crucial both in the past and the future mission.



Built on this historical continuum for the mission of NLM, the Panel projects a vision of the future. The library of record for biomedicine is seen as a distributed network in which NLM serves as the coordinating focal point and as the source of last resort. Development of biomedical librarianship and informatics is seen as a continuing responsibility.

The “vision of the future” is then made specific to the frame of reference of this Panel, focusing on the collection, its scope, management, preservation, and organization and access. The collection policies of NLM provide a solid basis to which the Panel recommends major additions, especially with respect to electronic media. Special attention is given to the need for preservation of both printed and electronic forms of information. The organization of the collection is discussed, with emphasis on the importance of tools developed in the past and those needed in the future. Of special import are recommended extensions to *Index Medicus* and MEDLARS (Medical Literature Analysis and Retrieval System), including intercon-

nection of MEDLINE (MEDLARS Online) with other data bases; research into new methods of indexing and cataloging; and the development of a Unified Medical Language System.

Basing its conclusions on the statement of mission, the vision of the future, and the description of goals and objectives, the Panel presents a set of recommendations in the final section of this report. Some of them are considered of immediate importance, representing “windows of opportunity” that may be lost if not implemented now.

NLM Programs and Recent Accomplishments

The Mission of NLM

Today, the mission of NLM is a result of its own history, the central role it has had in medical research in the United States, and the specific recognition of its importance by the Congress of the United States.

The legislative history of NLM proper begins when it was established in 1956 by converting the former Armed Forces Medical Library. Milestones in that history are:

- 1956 The National Library of Medicine Act (Public Law 84-941), passed in 1956 (the NLM Act);
- 1956 The Report of the House Committee on Interstate and Foreign Commerce, which stressed the importance of the availability of NLM facilities and services to the public;
- 1965 The Medical Library Assistance Act (Public Law 89-291), passed in 1965 (the MLA Act);
- 1970 Comments by the Senate Committee on Labor and Public Welfare accompanying the 1970 reauthorization (to the effect that there had been insufficient funding of NLM to achieve the objectives of the NLM Act and the MLA Act); and
- 1976 Comments by the House Committee on Interstate and Foreign Commerce (criticizing NLM for not adequately serving needs in 1976, and then commenting on the substantial progress made in doing so, in 1977).

As this history shows, the NLM Act was passed in 1956, in large part in response to the recommendation of the Hoover Commission. The act authorized the Library to be responsible for a wide range of activities with respect to medical literature. In the years since then, there has been little if any diminution of that responsibility. In fact, it has expanded significantly.

The Mandate Under the NLM Act
Explicit in the NLM Act is a set of congressionally mandated responsibilities:

...to assist the advancement of medical and related sciences, and to aid the dissemination and exchange of scientific and other information important to the progress of medicine and to the public health.

The importance with which Congress viewed this mandate is well illustrated by the *Report of the Senate Committee on Labor and Human Welfare*:

[NLM's] services are essential to men and women engaged in medical research throughout the world; to our medical and dental schools; to practitioners in the health field throughout America; to scientists, to scholars, to public health workers and hospital administrators; and to our Departments of Government.

The NLM Act identified an exceptionally broad set of functions to carry out the congressional mandate:

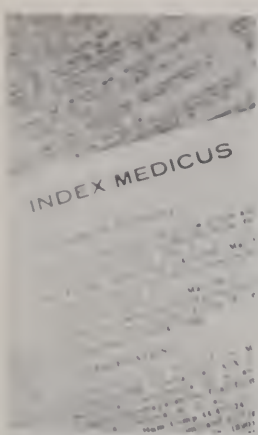
- (1) acquire and preserve...library materials pertinent to medicine;
- (2) organize [those] materials by appropriate cataloging, indexing, and bibliographic listing;



- (3) publish and make available [those] catalogs, indexes, and bibliographies;
- (4) make available, through loans, photographic or other copying procedures or otherwise, such materials...;
- (5) provide reference and research assistance; and
- (6) engage in such other activities in furtherance of the purpose of this part as [the Secretary] deems appropriate and the Library's resources permit.

The Mandate Under the MLA Act

In 1960, members of the NLM Board of Regents discussed the desirability of awarding grants to train librarians, prepare special bibliographic reviews, support research in the history of medicine, and assist other medical libraries to improve their services. The explosion of new medical research in the 1950's and beyond had severely taxed medical libraries, whose personnel and facilities were unable to keep abreast of the heavy informational demands being made on them. With the proliferation of new scientific data, physicians and medical scientists were having increasing difficulty in quickly obtaining new information about new medical procedures and drugs.



In the mid-1960's, the chairman of the President's Commission on Heart Disease, Cancer and Stroke pointed out the need to strengthen the Nation's medical libraries, and the report of that Commission in December 1964 recommended that the Government recognize public information as a primary responsibility and major instrument for the prevention and control of disease. It further recommended that NLM, as the core resource for information in the biomedical sciences, be supported and expanded on a scale commensurate with its importance. As a result, in 1965, the MLA Act (Public Law 89-291) was passed.

The MLA Act extended the responsibilities of NLM into a set of national responsibilities, authorizing activities to assist medical libraries throughout the country, including establishment of regional branches of NLM to facilitate the delivery of services and to enhance cost-effectiveness through the sharing of resources. Specifically, it called for NLM to:

- (1) assist in construction of...facilities;
- (2) assist in training...personnel;
- (3) financially assist...in the compilation of new scientific knowledge;
- (4) assist in the development of innovative technological advancements in medical library techniques;
- (5) assist in the expansion of resources and services of medical libraries;
- (6) assist in the establishment of a system of regional medical libraries to coordinate the geographic sharing of resources; and
- (7) assist financially in the publication of biomedical science works.

The thalidomide scare helped persuade Senator Hubert H. Humphrey of the need to establish a special program in the Library for the prompt collection, organization, and dissemination of new medical information, including that about harmful drugs. The result was establishment of a National Drug Information Clearinghouse in NLM. In 1967, the Public Health Audio-visual Center was transferred to NLM and the Toxicology Information Program was founded. The Library now offers an online Toxicology Information Service, which is valuable to physicians and scientists, industry and governmental agencies, and anyone concerned with protection of individuals and society from catastrophic toxic spills and other environmental crises. In 1968, the Lister Hill National Center for Biomedical Communications was established, named for the Senator who promoted its establishment in Congress.

Development of the NLM Collection

Beginning in 1836, NLM evolved from a small collection of books and journals in the Office of the Surgeon General of the Medical Department of the Army. Although the Civil War stimulated use of the Library and development of its collection, it had grown to only 1,800 volumes by 1864. But after Lee's surrender at Appomattox, the Army closed temporary military hospitals and sent the most valuable books from any associated libraries to the Surgeon General's Library in Washington.

In October 1865, responsibility for the growing collection of books and journals was entrusted to Dr. John Shaw Billings. Under his direction, acquisitions expanded dramatically. By the end of 1870, he presided over one of the largest medical libraries in the United States, exceeded only by those of the Pennsylvania Hospital and the College of Physicians in Philadelphia.

In subsequent decades, the objectives of the Library were broadened to include service to the entire American medical profession, not only the military. The goal was to develop it as a "National Medical Library" with a collection of medical literature that would contain "every medical book published in this country and every work relating to public health and state medicine." By the time Billings left his post in 1895, the collection had grown to over 73,000 books, 39,000 volumes of journals and transactions, and 200,000 individual pamphlets and theses. During Billings' tenure, the Library also made its first significant efforts to acquire rare books, manuscripts, prints, and photographs on the history of medicine, and to develop literature exchange programs with domestic and foreign institutions.

Over the course of the first half of the 20th century, the collection continued to expand, although in the years between World War I and World War II, lack of adequate funding and staff made it impossible for the Library to acquire all the relevant materials being published. When World War II came, fear for the safety of the Library's rare books and historical materials led to their consolidation and transfer to Cleveland, where systematic preservation treatment was begun. The wartime demand for increased service stimulated a survey of the Army Medical Library by a group of distinguished librarians, who were asked to suggest ways of improving the Library's operations and

management. The resulting report recommended an aggressive acquisition program, including an increased book budget and an active gift and exchange program.

The war over, the Library set out to remedy the deficiencies identified. In 1949, in order to focus the continuing postwar growth of the collection, Director Frank Bradway Rogers established an internal Committee on Scope and Coverage "to define the subjects to be collected and the degree of collecting within each subject." The Committee determined the medical and nonmedical subjects (such as physics, chemistry, and technology) the Library should acquire. It also defined four degrees of coverage for the subjects: skeletal, reference, research, and exhaustive. Finally, it recommended policies for specialized areas within the Library, including an art section and the History of Medicine Division. The Committee's report provided a basic guide for the selection of materials for the collection, which has since been revised periodically. The most recent revision of the selection guidelines appeared in 1985, as the *Collection Development Manual of the National Library of Medicine*.

During the last several decades, which have seen the vast proliferation of scientific literature, NLM's collection budget has remained about 3 percent of the Library's total operating budget. General collection development policies have had to become focused increasingly more narrowly within the following recent general boundaries: scholarly, in contrast to ephemeral, materials; biomedical, in contrast to general, sciences; and written for the health professional, in contrast to the layman.

NLM Collection*

Book material (monographs, bound serials, pamphlets, theses 1,830,000

Nonbook material (microforms, audiovisuals, manuscripts, pictures 1,918,000

Current serials received 22,600

*As of September 30, 1986

As automation of the Library's operations proceeded, NLM also initiated a program for preservation microfilming of pre-1906 issues of *Index Medicus* titles and selected historical monographs. This activity peaked in the late 1970's and early 1980's. It was discontinued temporarily in 1982, after completion of the filming of earlier *Index Medicus* volumes. At that time, the Library began research activities related to mass storage for preservation purposes on optical disks.

In 1983, the Library Operations Program identified the development of a comprehensive preservation program for the biomedical literature as one of the four major objectives of its strategic plan for 1984-88. A Preservation Planning Team was established in 1984 to survey the condition and storage environment of NLM's collection and to develop a preservation plan. The Team's report was submitted and accepted in 1985. As a result, NLM is creating a Preservation Section, resuming high-volume preservation microfilming, expanding its research in mass storage on optical disks, and planning for the deacidification of the bulk of its collection.

Development of Means for Access to the Collection

When the Library was officially designated the National Library of Medicine by Act of Congress, the basic functions outlined in the NLM legislation were those that Billings had defined 80 years before: not only to acquire and preserve library materials pertinent to medicine, but to organize these materials by appropriate cataloging, indexing, and bibliographic listing. Indeed, perhaps even more significant than Billings' contributions to the development of the NLM collection (then the Surgeon General's Library, of course) were his remarkable efforts to organize the material collected. Billings was the first to define the Library's role in providing intellectual access to the medical literature, not only for on-site users of the collection, but also for medical professionals throughout the United States and the world.

The Indexing Publications of NLM

Billings began publication of the *Index Catalogue* in 1880. It appeared in a series of volumes, in alphabetical order, the last of which was published in 1895. It made the collection of NLM available through interlibrary loan to physicians throughout the United States and Canada. It thus made the Library truly an international resource. Of course, even while the *Index Catalogue* was being produced, the Library continued to grow; when it was completed it was necessary to produce a second, a third, and then a fourth series. The fourth series was never actually completed as planned, being terminated with Volume 11 (Mh-Mn), although it was supplemented in 1959 and 1961 by a "fifth series" of three volumes of purely monographic references.



Basing his plan on the evident success of the *Index Catalogue*, and recognizing the problems of keeping current, Billings, together with Dr. Robert Fletcher, created the first *Index Medicus* in 1879 as a monthly index to the world's medical literature. It provided current information to supplement the *Index Catalogue*, whose many volumes took so long to complete. That early publication served as the intellectual model for today's *Index Medicus*.

In the ensuing years, a variety of other access tools were pioneered by NLM. The *Quarterly Cumulative Index Medicus* was started in 1927, and provided specialized bibliographies as supplements to *Index*

Catalogue volumes; the *Current List of Medical Literature* began in 1941. The latter is of special interest because, with funds from the Rockefeller Foundation and the Pan American Union, free copies were sent to medical institutions in Central and South America, further expanding NLM's international influence.

Thus, over the course of the first half of the 20th century, the Library continued to publish indexes and catalogs. However, in the years between World War I and World War II, lack of adequate funding and staff made it impossible for NLM to provide current and comprehensive cataloging and indexing services. As a result, the survey of the Army Medical Library stimulated by the wartime demand for increased service recommended adoption of more standard cataloging practices, improved indexing procedures, the development of a new classification system, and the revision of the subject headings used by the Library.

munity. In the early 1970's, NLM initiated the MEDLINE service, which provided online access to NLM indexing records for users throughout the United States via nationwide telecommunications networks. From this beginning, NLM's own current online services network has grown to include 21 online files. NLM's data are also distributed in machine-readable form and made available on many computer systems throughout the world.

While developing and improving online access to its indexes in the 1970's and 1980's, NLM also automated many technical processing functions, such as ordering and receiving materials for the collection, maintaining binding and preservation records, and creating cataloging and indexing records. To support acquisitions, cataloging, reference, and document-delivery functions, the vast majority of those NLM cataloging records created before the advent of MEDLARS were converted to machine-readable form. Today, virtually all internal operations related to developing and organizing the Library's collections are handled through a variety of sophisticated online systems. The Library's current MEDLARS III development effort is designed to replace these several applications with an integrated automated system for building, organizing, and controlling the Library's collection, as well as supporting information retrieval and document delivery.

Physical Organization

MEDLARS III is intended to provide an integrated system with a single master bibliographic record for each item in the collection. Linking each physical entity with the corresponding record by machine language barcode will enable materials to be readily traced and inventoried. NLM's closed-stack environment eliminates any great concern about collection control, vandalism, or theft. However, the security of an increasing number of electronic data bases, and access to them, may raise problems that need to be addressed. Arrangement by classification, even NLM's own, should not be sacrosanct; materials may be located electronically and even retrieved by robots.

The Persons and Groups Served by NLM

NLM today provides services to users in several distinct ways:

- Utilization of the collection at the Library itself;
- Utilization of the collection through interlibrary lending of documents and photocopies through the RML (Regional Medical Library) network and DOCLINE (NLM's automated interlibrary loan request and routing system);
- Generation of the bibliographic tools, such as *Index Medicus*, that provide the means for access to the world's biomedical literature;
- Creation of MEDLINE and other data bases for use in online access services; and
- Provision of online access to data bases produced by NLM, such as MEDLINE, TOXLINE (Toxicology Information Online), PDQ (Physician Data Query), etc.

Indexing Citations Added to the Data Base*

fy1983	310,445
fy1984	306,263
fy1985	307,333
fy1986	316,585

Includes Index Medicus, special list articles, audiotapes, and Health Administration citations



The users of these services and their purposes vary widely from service to service, so generalization is difficult. The available statistical data, however, imply that the principal end-user groups are health-care practitioners, with commercial users, biomedical researchers, educators, and students having much lower frequency of use. For example, in September 1985, the statistics showed the following distribution of use of NLM's online services:

- "Patient care users"—i.e., hospitals, in-patient facilities, health professionals—were the highest number of billed users of MEDLARS data bases (57.7 percent);
- Business users—pharmaceuticals, suppliers to health-care facilities, food and agriculture, chemical companies, etc.—ranked second (11.9 percent);
- Education users were third (9.7 percent);
- General services, such as publishers and law firms, were fourth (8.3 percent);
- Research users ranked fifth (7.7 percent); and
- Governmental use in connection with legislation and regulation ranked sixth (3.9 percent).

(It should be noted that these figures are based solely on use of NLM's own computer systems and therefore do not include other means for distribution, such as DIA-LOG Information Retrieval Service, BRS Information Technologies, Mead Data Central, PaperChase, and miniMedline, which include MEDLINE among their data bases. The distribution of users of those commercial services may be significantly different from that of NLM services.) These generalized figures illustrate the types of user groups, but they reveal little of their purposes. In any event, whatever

its purposes, it is clear that the community of users covers a broad spectrum, ranging from educators to students, from researchers to practitioners, from commerce to government, from those for whom health is central to those for whom it is tangential.

International Responsibilities

Because of the international nature of research and scholarship, as well as the global nature of disease, an important aspect of NLM has been its international activity. The Panel strongly believes that NLM has a major international responsibility with at least four important aspects. First is the international scope of the material that NLM should and must acquire; we are increasingly dependent upon the results of foreign research, so we need data from other countries and we need to assure the availability of those data. Second, indexing done under international MEDLARS agreements has assisted NLM in covering biomedical literature published worldwide. Third, the United States must participate with other countries in the development of international standards; in that work, NLM has played a central and vital role and has served as a very valuable representative of U.S. interests by doing so. Fourth, NLM serves as the international resource on which all other countries depend; today, nearly half of the orders for *Index Medicus* come from non-U.S. customers.

Collecting Internationally

With respect to the first responsibility, there was unanimity in the Panel: it is indeed essential that NLM's collection policies cover the entire world's literature. The United States is increasingly dependent on the results of foreign research, so that we need data from other countries. The world of biomedical information is not limited to what is produced in the United States; it spans the globe. The NLM collection must be international in scope to ensure document access.

Indexing Internationally

With respect to the second responsibility, bibliographic access to that broad world of information is imperative for all researchers, since they build on the efforts of others. We need to make sure those data are cited in *Index Medicus*. NLM indexing is being done under international arrangements that assist the Library in covering foreign research. If such activities are not continued, the dynamic exchange among researchers who have been linked by published documents can only diminish, with a resulting diminution in advances in the biomedical fields.

International Standards

With respect to the third responsibility, there was general consensus that NLM should play an active role in promoting international standards, but should do so in cooperation with other national libraries and public and private agencies. In particular, the development by IFLA (International Federation of Library Associations and Institutions) of international standard bibliographic descriptions for a wide variety of materials has contributed substantially to achieving compatibility in this

Volumes Cataloged	
fy1983	18,448
fy1984	17,510
fy1985	17,176
fy1986	20,285

area. At the same time, the ISBN (International Standard Book Number) and ISSN (International Standard Serial Number) allow for the unique identification of these bibliographic items, and thus facilitate the interlinking of different data bases. Much less has been achieved in securing compatibility in the processing of component parts of works, especially journal articles. A key element could be the development of a Unified Medical Language System that would assist in the convertibility and transmission of data and information relating to research, medical care, and patients' records.

Mechanisms for executing future international programs will vary and be dependent upon advances in existing technologies and new technologies. Hence, the current international biomedical communications network created through MEDLARS agreements may take a different form, and new modalities and repackaging of information will be important elements in the transmission of both information and literature. Future methods for the acquisition of literature, and its indexing, availability, and dissemination should be as technically advanced as possible, as well as economical and efficient.

NLM should be encouraged to continue to develop new effective working relationships with other U.S. agencies, domestic and international professional organizations, other governments, and international governmental health organizations. In this way, there can be integrated programs that are not possible or feasible by individuals' independent efforts.

International Services

With respect to the fourth responsibility, NLM is viewed as an international resource for biomedical research and services. Its collections reflect the importance of foreign literature to research and practice in the United States. There was general agreement that that status should be encouraged and preserved, although there were divergent views about the extent to which NLM should take a "pro-active" position in providing services internationally. Some members of the Panel believed that NLM should build an international program as a programmatic objective; others argued that the international program should be regarded simply as a natural result of the primary responsibility to the American public.

NLM is unique and is recognized as a world leader in biomedical communications. NLM's international stature is not accidental, but derives from its development of positive, cooperative, and substantive programs. These include: exchange of materials and services; MEDLARS *quid pro quo* agreements; the Special Foreign Currency program; provision of policy and technical consultation on the development of national and international biomedical and health information resources; training of individuals who will subsequently serve as leaders or technical information experts in their countries; and joint programs with the Pan American Health Organization and the World Health Organization, which have improved access to biomedical and health information through the establishment of national and regional resources, the provision of specialized recurring bibliographies, and information services.

NLM'S policy, based on a principle of sharing talent, resources, and time rather than unilateral expenditure of funds, has encouraged stable programs and operations and has enriched U.S. and international biomedical research and health. NLM has increased and improved biomedical communications in collaboration with scientifically sophisticated countries. Simultaneously, it has implemented activities that respond to the needs of the developing world. These programs have enhanced human dignity and contributed to improved understanding among nations.

It is especially important to note, in both the international arena and the United States itself, that great differences exist in the ability to deal with new technologies. Small, developing countries and small communities in the United States may lack the resources for them. Therefore, for at least the coming 5-year period, and possibly even for the 20-year period, it will be essential for NLM to continue to provide its publications and services in the traditional as well as the newer forms.

NLM Role in Development of the Biomedical Information Profession

As we have indicated, NLM, by both example and program, has played a central role in the development of the national biomedical information system. The MLA Act, in particular, has provided the means for NLM to assist in the dramatic improvement of the system for delivery of information services for medical research and practice.

Health Science Libraries

In 1953, a report, *Medical Schools in the United States at Mid-Century*, indicated a serious problem with the Nation's medical school libraries.¹ The following decade saw no improvement. Another report in 1957 identified a similar problem with respect to hospital libraries.² The demands of research and practice were simply outstripping the existing resources and facilities.

Since 1967, through the encouragement of NLM and with some direct financial support under the MLA Act, there have been dramatic improvements, with the greatest expansion in the history of medical libraries. Much of this growth represented increasing awareness that information resources were crucial elements of medical research and practice.

Training of Medical Librarians

By its towering achievements, NLM has set an example that has led all medical librarians to aim for excellence, and it has also provided the tools for medical librarians to achieve that excellence. For many years, NLM served as the place from which a generation of medical librarians gained their experience and commitment.

The report by Senator Lister Hill's Committee to the Senate in 1965 identified a "critical shortage of professional personnel trained to meet the special needs of health science libraries and the medical community they serve."³ The MLA Act Training Grants were designed to address this problem. From 1966 to 1971, a total of 115 training grants were awarded to medical librarians. As a result, the number of master's level educational programs increased from two prior to 1966 to eight by 1972. Since then, the focus of NLM support for training has been on application of computer technology to the health sciences.

Support of Publication

Since passage of the MLA Act, NLM has fostered the creation of scholarly reviews, synopses, handbooks, and other forms of secondary publication as tools for the organization of medical knowledge. Distinguished scholar-scientists have completed major works on topics such as hepatotoxicity, epidemiology of diabetes, and the evolution of the legal principles that affect health professionals.

Development of New Techniques for Information Processing

NLM has been at the forefront of the development of new methods for information handling, especially in the use of computers and telecommunication equipment. We have already commented on those within NLM's own operations. Beyond those, however, are the research programs fostered by NLM under the auspices of the MLA Act. Of special importance have been the studies undertaken in the computers-in-medicine program and medical informatics.

The RML Network

In some respects, the most fundamental contribution of NLM has been in creation of the RML Program. Through it and through Resource Grants, NLM has laid the basis for the kind of distributed information infrastructure that this Panel considers the right direction for future development of the Nation's medical information system. These have both assisted in the acquisition of library materials and, since 1970, in the improvement and extension of the information services provided by the biomedical library community. The result has been an efficient and highly effective system with active involvement of scores of libraries throughout the country, each with an important responsibility, and with NLM serving as the centerpiece.

The Contributions of NLM Services and Functions

That NLM should be providing information services seems unquestionable. The NLM Act says that "the Library shall...publish and make available the catalogs, indexes and bibliographies [that it is also required to produce]." The MLA Act authorizes NLM to "assist in the development of innovative technological advancements in medical library techniques," and thus provides the basis for NLM to use modern computer methods to make available the catalogs, indexes, and bibliographies.

In carrying out its legislative responsibilities, NLM has made many contributions to building medical collections and organizing biomedical information. These include:

Medical Subject Headings. The National Library of Medicine created the MeSH (Medical Subject Headings) thesaurus, a standardized terminology used to describe the content of articles and books and a powerful tool for providing efficient access to medical information in both its printed publications and its online database services. It serves as the cornerstone for medical libraries throughout the world in their own systems for access.

NLM Classification System. NLM has developed a classification system for its own collection that groups medical books according to their logical relationships to each other. The system serves as the model for all medical libraries.

Explicit Collection Development Policy and Guidelines. A collection development policy was first established in 1949–50 and revised at regular intervals since that time. It provides a consistent and predictable guide not only to NLM but to all libraries that depend upon it for assurance of coverage of the field of medical literature.

Indexes and Catalogs to the Biomedical Literature. For over 100 years, NLM has provided the premier tools for access to the contents of books and journals in biomedicine through its published indexes and catalogs.

Pioneering Use of Automation. Beginning in the early 1960's, NLM has pioneered the use of computer methods and telecommunications to distribute indexing and cataloging data. This included an early, perhaps the first, use of automated subject authority validation and control for indexing and cataloging, which began in 1965. Name authority file validation for cataloging appeared in 1975. It is possible that NLM had the first automated name authority file. By 1983, NLM had a virtually complete retrospective conversion of catalog records for printed materials in its collection. NLM has developed sophisticated online systems for many aspects of its internal technical processing, including online acquisitions, check-in, cataloging, indexing, bindery preparation, and invoice control. It also demonstrated the potential for powerful integrated library systems using minicomputer technology.

Pioneering Use of External Services. From an early time, NLM developed policies for use of contractual services to extend the expertise and manpower of internal staff for indexing and cataloging, for bindery preparation, and for use of subscription agents and book dealers to provide special processing services (e.g., offsite check-in, machine-readable invoices).

Graphic Arts Quality. At a time when computer printout was available as “upper-case only” tabulations, NLM specified a need for graphic arts quality in its printed publications. The result was the development of GRACE, probably the first quality computer-controlled printing equipment. By demonstrating that such computer output was operationally feasible, NLM created the precursor, if not the stimulus, for computer-based publishing in general.

Online Retrieval Services. In MEDLINE, NLM provided one of the first online services and virtually overnight created a new industry.

Other Online Medical Information Services. By creating other online information services, NLM added further dimension to the revolution in online access, and demonstrated that it could encompass more than simply reference services by immediately bringing the basic information itself to those who need it.

Capital Investment in Collection and Organization. In establishing and maintaining its collection and creating tools for its organization, NLM has produced a capital resource of great importance, one that both the private sector and the Government can use for the production of a wide range of products and services. As a result, it is a premier national capital resource.

Advancement of the Nation's Biomedical Information System. Finally, through the auspices of the MLA Act and the resulting NLM initiatives, a biomedical information system of great quality and strength has been created in the United States.

Although this institution has received little public attention, it has given American citizens remarkable dividends for their tax dollars. NLM, with its vast, current, instantly retrievable electronic data base of medical and scientific knowledge, is the most comprehensive source in the world and is indispensable to the American health-care system.

With relatively modest funds, NLM has exceeded all expectations in fulfilling its several mandates and has emerged as the foremost medical library in the world. It has been at the forefront of the conversion to electronic data bases and has engaged in innovative research in medical decision making and artificial intelligence. Its success is a tribute to its former and present Directors, its dedicated staff, its consultants, and its Boards of Regents, who have contributed much time, knowledge, and skill to the improvement of NLM.

Now, many decades after the report of the Hoover Commission and two decades after the report of the Commission on Heart Disease, Cancer and Stroke, it is time to assess progress made as a result of their recommendations and to determine the areas where future emphasis or recommendations are required to meet future needs for medical information.

The Distant Goal

In a background paper he prepared for this planning process, Dr. Donald Lindberg, Director of NLM, presented a vision of the future—the Distant Goal as he perceived it. The Panel found itself in full agreement with the general objectives it presented and endorses that Distant Goal.

Specifically, the vision of the future foresees biomedical libraries of varying size and complexity continuing to exist throughout the country. There will be a substantial cadre of well-trained library professionals who are able to provide the information resources needed by health science professionals. They will have developed their qualifications through both academic and special training programs. They will be able to cover the broad range of subject interests by providing access not only to their own collections, but to those of the national system of libraries and to computer-readable files.

Through this system of biomedical libraries, all health professionals in the United States will be able to obtain information assistance regardless of the source or form of data. In particular, NLM and other biomedical libraries will provide ready access to computer-based citations, abstracts, full-text, and raw data appendiceal files. There will be support from associated programs that explain these data bases and provide tutorials and other means for using them to teach and test. There will be computer-provided consultation systems, using knowledge-based expert systems.

Beyond the support provided by the biomedical libraries, the health professionals themselves will have achieved considerable experience and skill in gaining access to automated information resources. They will use interlinked systems that provide access to patient care data, literature, consultation support, and continuing education—all potentially within a single computer session. To facilitate this interlinking, there will be a Unified Medical Language System through which the terminologies used in the several data bases are automatically mapped to each other.

The Panel sees the future in challenging terms. Present and emerging technologies for information storage, access, transmission, and reception suggest a reasonable ideal for a comprehensive health sciences information system in the United States in the next two decades. This would be a system in which any health science professional could use a portable terminal to access data bases from NLM and elsewhere easily and cheaply from any location. The system would provide both immediate answers to vital questions and guides to further sources to meet nonimmediate needs. While NLM cannot be solely responsible for building such a system, it certainly can take the lead under its congressional mandate. It can stimulate the design and help to build it, in collaboration with biomedical libraries, publishers, technology providers, and health science institutions.



The Library of Record for Biomedicine

Historically, NLM has served as the library of record in the fields of medicine and allied health science. Its central role as a national library has served to provide assured and convenient access to the archival intellectual resources underpinning the Nation's research and clinical activities in medicine and allied health fields.

In support of the view that NLM should be the library of record for its scope of subject responsibility, reference must be made to the dependence of other libraries upon that expectation. Viewed in terms of national costs, it is more effective for NLM to guarantee preservation of a copy of a resource than for each of several libraries to preserve the same item. Beyond cost, however, it should be pointed out that such a responsibility is consistent with its national mandate.

To date, NLM has achieved its objectives through a comprehensive collection policy. Under this policy, it collected all published materials relevant to the field of medicine as defined by both the clinical needs and the new directions and scope of medical research. Within this context, then, NLM should continue to cover the historical record, both in terms of the "history of medicine," as currently interpreted (and thus to acquire material of historical importance), and in terms of providing the record of the present for future scholarship.

It must be recognized, though, that changes are occurring in the manner in which information is generated, disseminated, and stored. At the same time, there are fundamental shifts in user requirements and perceptions of relevant disciplinary fields. It is evident that publishers are experimenting with the use of computer methods as alternative means for publishing. For example, the *Annals of Internal Medicine* is now developing plans for a new journal to be published purely in electronic form. Given these developments, it must be the responsibility of NLM to assure the continuing availability of such material in the future.

In recognition of the past, of the current changes, and of the vision of the future, the Panel concluded that, functionally, NLM should continue to serve as the "library of record" for medicine and the health sciences generally. However, that responsibility must be carried out with the recognition that no one library can preserve everything; there must be criteria for selection, and the concept of library of record must be interpreted in light of the new information infrastructure now being developed in the United States.

The New Information Infrastructure

While it is clearly desirable for NLM to continue in its role of the library of record for its scope of subject responsibility, it will become increasingly important for NLM to define this role carefully, in light of the new information infrastructure feasible in an electronic environment. As a means to do so, the Panel recommends expanding and strengthening the RML Program to provide NLM and the community using it with a means to identify locations of materials, refer to them, and access them, perhaps through electronic means.

As it has in the past, therefore, NLM should continue its leadership role and move to define and implement a comprehensive, coordinated, physically decentralized system for the collection and preservation of medical literature as traditionally defined. The Library must also provide access tools and gateways to literature sources in related disciplines.

Changes in the Scope of the Collection

NLM's collection scope has been traditionally confined to the definition of medicine as a clinical field, but those perimeters are now rapidly disappearing as research becomes increasingly interdisciplinary. In one sense, the scope includes all of the natural sciences, a great deal of social science, and a healthy portion of the humanities. Access to this breadth of materials requires a system combining the Library of Congress, the National Agricultural Library, and the Nation's more than 100 major research libraries.

The Panel agrees with the view that NLM should provide means for access to the complete coverage of basic works in all subject disciplines that intersect with biomedicine. Specifically, NLM's collection and services should be viewed as part of a broad array of information resources and used in conjunction with other services. In implementing such a program, it seems advisable to continue the current policy of acquiring only a small number of works in subject areas that intersect biomedicine but are not central to it; the aim should be coverage sufficient to define the subject in question and direct users to more comprehensive sources. This will avoid expansion of NLM's collection into areas already well covered by the Library of Congress and other general research libraries. NLM should continue to acquire comprehensively works that apply these subject disciplines to the problems of medicine and health care.

In this respect, it is evident that the three great national libraries—the Library of Congress, the National Agricultural Library, and NLM—should work together closely with respect to cooperative acquisitions, thus keeping overlap to a minimum. The Panel thinks that these arrangements should be formalized, and that consideration should be given to the development of a national collection policy to include guidelines on scope, coverage, and format for all three national libraries. In addition, NLM should participate in the program of the Association of Research Libraries to develop conspectus data for all its members, and should work with and support the efforts of the Medical Library Association and the Association of Academic Health Sciences Library Directors to gather comparable data about the collections and policies of health sciences libraries in the United States. The accumulation of uniform data on the collections of general and health sciences libraries is a requisite to developing

national programs for shared acquisitions, cataloging, and preservation responsibilities and for directing user requests to alternate sources of information.

The Effects of Information Technology

In view of the developing importance of computer-based information resources, access is needed to the many abstracting services and related data bases that provide excellent coverage of materials newly of interest to medical researchers and practitioners.

Achieving what is potentially feasible in services will require the solution of problems of access to many data bases. The goal should be to have the systems of the major providers of online services all interconnected through means that could steer searchers from any point of entry to the directions appropriate to meet their needs. The basis for this is already being developed in the "linked systems protocol," but such a concept also suggests the need for an interlinking of thesauri and indexes.

The Richness of the National Distributed Collection

Even within any narrowly identified scope of biomedical materials, there is more than any single library can acquire. Indeed, among the Nation's biomedical libraries are many collections of unique materials to which access is needed. There is no indication that the proliferation of the literature of biomedicine is going to abate. Research has produced massive increases in the amount of medical information during the last several decades, and it is the preparation of an article or series of articles for publication that brings closure to a research project. This has created the need for additional information resources so that the physician can make well-informed decisions.

Development of Medical Librarianship

The Library has long served as the central focus for the continuing development of new information services and systems of access to information vital to the medical profession. In this latter role, NLM has demonstrated the essential role of a national information capacity committed to the support of a vital social service, making immeasurable contributions to the political, economic, and social health of the society.

As it has in the past, NLM has an opportunity in the future to maintain the level of excellence in medical librarianship. This is of special importance if the concept of a "distributed library of record" is indeed to succeed and to maintain ready accessibility for all relevant medical literature.

The New Need for Professional Leadership in Medical Librarianship

Today, as described so well by Matheson and Cooper, there is the beginning of serious planning for an integrated information system in academic health sciences centers.⁴ However, very few persons are qualified to manage such systems. Educational programs and internships are needed that will provide the upgraded knowledge bases required for these responsibilities.

In this context, then, NLM should encourage the development of new programs both to educate medical librarians and medical library systems analysts in library schools and to provide internship training in selected biomedical libraries with the necessary environment of excellence.

Resources and Facilities in Biomedical Libraries

If the distributed approach to the national library of record for biomedicine is to be effective, NLM will need to continue its leadership in assisting existing health sciences libraries to become health information management centers. There will be need to acquire both printed and electronic information media; there will be need for equipment to store and access computer-based media such as CD-ROM publications; there will be need for telecommunication equipment to enable participation in the national system.

Research on Information Handling Methods

To achieve this system will require the solution of a wide range of basic problems in information handling. There should be a new research agenda that includes but is not limited to the following: development of new techniques, systems, and equipment for processing, storing, and retrieving biomedical information; study of the uses of information by scientists, teachers, students, and practitioners; development of methods for evaluation of system effectiveness and efficiency; and design of methods to facilitate the assimilation and use of information by users.

Development of Medical Informatics

Beyond the work of the medical library professional, the capabilities of the new information technologies have had and will continue to have a fundamental and revolutionary impact on the manner in which scientists acquire, use, and disseminate information. The capacity to organize and manipulate information in machine-readable formats by sophisticated retrieval systems and the use of Boolean logic have stimulated different ways of thinking about and conceptualizing scientific inquiries. The graphics capability of computers makes possible the creation of multidimensional models in machine-readable form that become important tools in visualizing research results and communicating them among laboratories. Communications technologies, coupled with the widespread use of microcomputers, now support rapid, global transmission of research findings and numeric, graphic, textual, and other forms of data. As a result, patterns of both formal and informal collegial communications among scientists are changing dramatically. Most scientists now require convenient access to information in both digitized and printed forms.

In this respect, then, NLM should aspire to be a leader in the development of medical informatics. It should be a focal point around which the medical and library communities can work together in creating national recognition of this role for the medical library. The long-term implications for individual medical schools and hospitals would be large. Instead of regarding the medical library solely as a storehouse or even an access route to information, we should view it as a catalyst in information transfer and a force in medical education and practice that requires incorporation into the medical curriculum and hospital management.



This activist approach represents a switch in image, from a storage-and-service function to one of research, education, and management. The shift should occur without a break in continuity, but with appropriate changes in the functions of storage and service.

The Future Users

The rapidly changing environments of health-care delivery, medical technology, and the ever-increasing wealth of biomedical information create new needs and perhaps new users. What changes are occurring now and which may be anticipated over the next 20 years? What effect will they have on NLM's collection and its organization?

A 1984 Delphi study was conducted by Arthur Anderson for the American College of Hospital Administrators.⁵ The resulting report, *Health Care in the 1990's*, makes these predictions about the health-care delivery system and individual practice of medicine:

- Multihospital systems will continue to grow.
- The number of investor-owned hospitals will substantially increase.
- The amount of money spent nationally on health-care services will continue to grow.
- New types of providers will reduce the share of health-care expenditures going to the acute care, inpatient hospital.
- Emphasis in health care will shift to ambulatory services and new delivery services.
- Prospective payment systems will be extended to physicians, resulting in a relative drop in their income levels.
- Increased fiscal restraints and greater use of prescribed patient protocols portend less autonomy for tomorrow's physicians, more frequent conflict with their hospitals, and decline in professional satisfaction.

Based on these perceptions, it might even be anticipated that private practice could disappear, that more responsibility for primary care might be assumed by allied health professionals (nurses, nurse practitioners, pharmacists, physician's assistants, etc.), and that physicians will be the specialists in using and interpreting high technology.

Education for Health Care

With the growing recognition that traditional curricula for health-care professionals cannot continue to keep pace with the ever-widening body of knowledge that underpins and supports biomedicine, new methods of education are being sought. The *Report of the Project Panel on the General Professional Education of the Physician* encourages movement away from didactic lecture, and toward increased utilization of self-learning and problem solving.⁶ These changes in teaching methods require the development of new teaching tools, including computer-assisted instruction modules.

Biomedical Research

This area will also see numerous changes in the coming years. A report commissioned by the National Research Council, *Models for Biomedical Research: A New Perspective*, suggests the value of the study of invertebrates, lower vertebrates, microorganisms, and cell and tissue culture. This work is characterized as "having the same potential relevance to biomedical research as proposals for work on systems that are phylogenetically more closely related to humans."⁷ Access to data and the matrixing of data will become more and more critical to research.

Interest in Biomedical Information by Other Groups

With the projected increase in dollars in the health-care field, for-profit corporations are likely to become major users of biomedical information as they develop new products to meet demands.

Another growing user group is likely to be the consumer. Widespread public health education programs will increase the literacy of the population that may wish to use sophisticated information systems to provide self-care in many instances, including diagnosis of minor illnesses, purchase of nonprescription drugs, and the like.

The "right to health" philosophy will continue to create unrealistic expectations among consumers, and malpractice litigation will increase the demand for medical information for legal purposes by lawyers, health-care providers, and laymen.

Government agencies will have an ever-increasing need for data, as social issues of biomedicine continue to have a major impact on the fiscal health of governing bodies. The aging of Americans, expectations of the public, and the health care of the poor will be growing issues. Bioethical concerns, too, will be prominent, as new technology and new knowledge extend life expectancy and raise major questions about who shall live.

Intermediary Users

Much, if not most, of the use of NLM occurs through intermediaries such as librarians and information specialists. They generally use NLM as the source of last resort, at least with respect to use of the collection. Only if a loan request cannot be filled by another library in the hierarchical protocol is it sent to NLM. As biomedical libraries make holdings available online, the degree to which NLM must meet even those needs may well level out, with only requests for truly unique materials reaching NLM.

Data base use by intermediaries is likely to remain high and even to increase as the number of end users continues to grow, since their role is crucial in the process of access to and analysis of information.

The Nature of Future Use

There was considerable discussion of the likely future nature of the use of information resources. It was recognized that, in this respect, there is substantial overlap in interests among the several Panels and especially so between Panels One and Two. Both Panels considered the issues and seemed not to diverge, although the foci of their concerns were different. Panel One concluded the topic should be primarily the responsibility of Panel Two, but it is worthwhile to review some of the salient points considered by Panel One. Beyond that, however, it was suggested that there should be continuing assess-

ment of the needs of users. There was a view that the audience served by NLM will broaden; if that is the case, it is essential that the new needs be understood, the nature of new clientele be clearly defined, and the entire range of policies—collection, indexing, automation—be reviewed in the context of those needs.

Currently, NLM serves health professionals both directly and through the medical libraries of the country. The primary focus of much of the biomedical literature has been at the research end of the spectrum from research to practice. But an overwhelming proportion of medical work is carried out by those who read, at most, two or three journals, and they probably do not need much more information than that. The generalist does face the need to draw upon highly specialized knowledge, however; in the past, this has been done by drawing upon the specialist as the person with that knowledge.

There is increasing demand for integration of information, for digests, synoptic articles, and reviews. Increasingly, these might become the foci of printed journals, with the original research papers available electronically. This kind of need is especially characteristic of practitioners; their use of original research articles is slight compared to their use of synoptic papers. The question is the degree to which those kinds of integrating articles are accessible through the system. It was pointed out that most of the good synoptic articles are already in the scholarly literature—*New England Journal of Medicine*, *Annals of Internal Medicine*, and others. Some good articles appear in more popular journals such as *Scientific American*, but even these are selectively indexed by NLM.

Looking back 40 years, rather than ahead, the big changes that have occurred in medical practice are the vast increase in the number of effective therapies and a widening range of specialties. Now, the question facing clinicians is not whether a therapy exists, but which of those available should be used. This is part of the trend toward specialization, leading to “therapy advocates” rather than “patient advocates,” and weakening the role of the generalists. This massive development of therapies, through research, has created an increased need for information.

- Software identification, evaluation, and service;
- Access online to journals and data bases;
- Access to archival materials in both printed and electronic forms;
- Specialized reference assistance to supplement expert systems and artificial intelligence programs; and
- International linkages for access to disease control information.

Library users are likely to be critically concerned with the time needed to gain access to bibliographic records, to data, and to documents. They will be increasingly demanding with respect to convenience or ease of access, level of specificity or generality of information retrieved, and accuracy and comprehensiveness.

Meeting these needs might well require the following kinds of developments:

- A Unified Medical Language System to synthesize data from a wide range of sources;
- A compatible network with standardized linkages and interfaces;
- A compatible, standardized software system for accessing a range of sources;
- Expert systems to guide both sophisticated and first-time users through all systems and sources;
- Expanded abstracting and indexing, covering both primary research for the specialists and integrative and interpretive materials for clinicians and patients;

Major Issues and Future Directions

The Future Scope and Coverage of the Collection

There was wide-ranging discussion concerning the media to be acquired. Would print-and-paper materials still be important? Should newer media, such as compact disks, be actively acquired? What about numerical data bases, patient record systems and data, expert systems and other artificial intelligence packages, and software more generally?

The *Collection Development Manual of the National Library of Medicine, 1985*,⁸ is a comprehensive document that not only provides pertinent historical background regarding NLM's collection, but also delineates its scope and format and provides guidelines for the selection of nontraditional formats. The following views of Panel One appear to be consistent with those guidelines, but they may provide some additional perspective on them.

Printed Materials

Even given the radical changes in communication patterns in some fields of science and biomedicine, Panel One strongly believes that print-and-paper media in the traditional formats of books, journals, and reports will continue to be important forms of publication and acquisition for the NLM collection over the 20-year frame of reference. A variety of reasons support this belief. First, these media will continue to be an economical form of publication. Second, users still demand hard (i.e., paper) copy, and some groups will always need their information resources in traditional forms. Third, when new information media appear, they do not replace the older ones, even when predicted to do so. The example of "media" and microforms some 20 to 30 years ago illustrates this

point. Fourth, many users, such as those in small hospitals and in developing countries, will not have the equipment and resources needed for use of newer media for many years. Rather than replacing print, the newer technology will expand the range of information resources.

Electronic Publications

As discussed in the introduction to this report, a wide range of electronic forms of publication are either already in existence or soon will be. With respect to all of these kinds of materials, it is important to the health-care community and to the Nation's health sciences libraries that NLM continue in its leadership role. In this role, the library can make sure that the informational records of biomedicine, whatever their format, are preserved and made available for present and future scholarship. These newer formats represent technological experiments in packaging information. Although we may not know what the ultimate package will be, it is crucial that NLM, in cooperation with other agencies, define the ways to impose "bibliographic control" on the new formats and, most important, to find ways of guaranteeing "integrity of reference"—the audit trail that identifies where information was obtained and permits the reconstruction of exactly what that information was when it was obtained.

New technologies for storage and quick retrieval of huge amounts of text at low cost will almost certainly generate new types of "publications." Unless NLM oversees decisions and influences standards it will have to apply in covering these new publications, the new works are highly likely to generate problems *post hoc* for the Library.


What kinds and parts of electronically published literature should NLM index? In what medium and format should NLM expect publishers to deliver such publications, both for indexing and storage? Should NLM define such needs as including printed-out versions of such materials? Probably most important of all, what should the policy of the Library be with respect to remote accessing of such materials, and how would its policy relate to copyright issues?

Defining these problems, in collaboration with publishers and technical experts, should have the highest priority for NLM. The Library should take the lead in setting the standards needed to carry out its mandates and helping to guarantee the integrity of the health sciences literature for the user community at large. An ancillary part of such an effort could be to bring together the editorial and publishing community, including online publishers, to work toward a consensus on such technical questions as method and style for transmitting and displaying characters other than the usual Roman alphabetic and numeric characters.

The first issue is the scope of collection. Here, the consensus was that the collection policies should treat electronic media as they do printed material. In particular, it is crucial that the focus be on "published" data, meaning that it should be distributed and publicly available. Electronic storage raises extremely difficult

issues related to intellectual property rights; agreements must be reached with publishers of the full spectrum of materials to provide the basis for accessibility and use while recognizing the property rights. When access rights with no machine-readable copy of an electronic publication are ordinarily granted to a subscriber, NLM must negotiate with the publisher prior to subscribing to assure that the publications will be preserved by the publisher or that the Library will be granted the right to preserve a copy for storage in its own collection.

While very few electronic journals now exist and even fewer that are not counterparts of the printed forms, this situation is rapidly changing, and it is expected that numerous journals may be made available online. With respect to these new media, Panel One was especially concerned about the need to take steps now to assure the future availability of data stored in such dynamic, online files. At present, data bases developed by other organizations are not generally available on the NLM computer system; access to them is provided only for on-site users, via telecommunications links with other computer systems. But data currently online may no longer be readily available in 20 years. In what form will those data be stored, and what responsibility does NLM have to assure their future availability? Reference was made above to the concept of "integrity of reference," interpreted to mean that data to which reference is made today should be available in the future as the same data, unchanged. The problem is that in dynamic files, that integrity of reference may be lost.



Numerical and Other Basic Data Bases

NLM does not currently acquire numerical and other basic data bases, except in the very specific context of its online services, such as CHEMLINE, an online factual data base for chemical nomenclature. Instead, it depends upon other national agencies, such as NTIS (National Technical Information Service), to provide access to such data bases. With the potential production of such data bases in compact disk format, should this policy change? Thus, while machine-readable raw text and numerical and image data files are not currently collected, the policy regarding acquisition of this material is under review.

Computer-Based Instructional Materials

Substantive current computer-based educational materials designed for health professionals, including allied health personnel, now are collected very selectively on an experimental basis. The policy regarding acquisition of this material is under review.

History of Medicine Material and Historical Records

The vast historical collections now at NLM, including a significant archive of manuscripts, constitute a national treasure. They are used by scholars from all over the world. The History of Medicine Division houses and maintains this collection and produces an annual bibliography of the history of medicine, as well as useful catalogs of specific portions of the collection. Most recently, NLM has provided an online data base of references to the field used by scholars throughout the country.

Considering the value, both intrinsic and informational, of this historical record, NLM should continue to acquire informational materials of historical significance for its history of medicine collection in support of present and future scholarship. In the future, nontraditional formats should be considered logical candidates for acquisition.

A fuller discussion of history of medicine programs at NLM is contained in an appendix to this report.

Consumer Health Information

A natural accompaniment of the public's heightened interest in health matters, both personal and social, is a greater demand for health information. By decision of its Board of Regents, NLM does not comprehensively collect consumer health information. The Panel recognizes that this policy may be necessary, but it is also clear that collecting, organizing, packaging, and making available health information for the layman is a problem of major importance. No single agency of the Federal Government or within the private sector is addressing this issue in its manifold ramifications. Therefore, while the Panel agrees that the collection policy should not be changed to deal with this need, it believes that there is at least a requirement for bibliographic access. This issue will be discussed further in connection with bibliographical and organizational issues.

Materials for the Broad Range of Professional Users

The world of health care is changing rapidly. The role of the clinician today will probably not be the same tomorrow. Currently, specialization and the upgrading of other health-care professions imply improved training and education for nurses, physician's assistants, psychologists, nurse anesthetists, and dietitians. Through its collection development and indexing policies, NLM has included the specialty literature for these ancillary allied health professions. Such practices are expected to continue and be strengthened as these clinical specialists become more and more responsible for patient care. NLM is the national library for these practitioners, as it is for physicians and researchers. Hence, this body of literature is important for their continuing education.

No current policies encourage acquisitions for professionals other than those specific to health. The Panel sees no need to develop any such policy.

Patients' Records

The developing systems for patient record management were considered. An underlying question is whether NLM should take responsibility for acquiring such systems or data. The acquisition, organization, and analysis of patients' records raise many complex issues, including confidentiality, scientific reliability, and other legal, social, and economic considerations. Given the strain that present NLM services put on staff and facilities, it does not appear judicious to undertake the vast new project of assuming responsibility for such unpublished material of varying accuracy, significance, and quality.

Preservation of the Collection

Preservation of the Printed Biomedical Literature

The Panel endorses the recently developed preservation policy of NLM, as set forth in *Preservation of the Biomedical Literature: A Plan for the National Library of Medicine*.⁹ This policy is in accordance with the terms of the NLM Act and the clearly expressed intent of Congress. It confirms the fundamental responsibility of NLM to preserve permanently the content of books, periodicals, and other library materials pertinent to medicine, based on the guidelines described in the *Collection Development Manual of the National Library of Medicine*. With the view that NLM's principal responsibility is to ensure the preservation of the core biomedical literature, the Panel urges NLM to give high priority to implementation of the preservation policies.

A manual is to be developed setting forth operational guidelines and procedures for selecting items to be preserved, choosing preservation techniques, and processing items for preservation. *Preservation of the Biomedical Literature: A Plan for the National Library of Medicine* proposed a planning structure to the year 2000 with review every three years. The principles of the structure are readily extendible to the year 2006, the period of concern for this current planning process. The preservation plan discusses the establishment of a new Preservation Section in the Public Services Division, which would be responsible for the management of preservation programs, collection maintenance, technical preservation and conservation, education

and public information, and consultation and research. The latter function would be coordinated with the Lister Hill Center and/or other organizations. Such research efforts are crucial in the coming years for all formats, particularly electronically stored data.

At present, microfilming is the only process at NLM for converting information among formats for storage and preservation. Printed material is regularly preserved and stored in this manner.

The optical disk, with the capacity for storing both audiovisual and digital information, is expected to provide a storage medium with high-speed search and review capabilities and immense capacities. The video disk and/or the CD-ROM will provide excellent formats for storage and access. The Lister Hill Center should continue research on the characteristics of these formats using the prototype EDSR (Electronic Document Storage and Retrieval) system being developed there.

Preservation of Electronic Publications

Various electronic media are going to be available for "permanent" versions of electronic publication: CD-ROM, magnetic disks, and so on. What will be the "shelf-life" of the various media? Which ones will be most economical as methods of access? What are their limitations with regard to special displays—special characters, graphics, line or continuous-tone? The decisions made by the Library about these matters will almost certainly have a heavy influence on what will be done elsewhere in the library world. The problems and possibilities should be defined as soon as possible.

There was a general consensus that NLM should take the lead in working with other agencies, both public and private, in resolving the technical issues involved in preserving the electronic record and setting standards.

Application to Governmental Data Bases

The issue of preserving governmental data bases, in particular, requires special consideration to formulate a policy. While NLM cannot assume the task of assuring the preservation of all governmental data bases, it should attempt to assure that those related to biomedicine are preserved, even if outside its purview. By cooperating with the National Agricultural Library, the Library of Congress, and the National Archives, NLM should seek to establish agreements to preserve electronic media that are related to biomedicine and meet its criteria for preservation.

Major questions to be addressed include:

- (1) What information should be preserved? Data such as statistical compilations or bibliographic data bases would seem to require storage that allows manipulation. Textual data such as administrative or program records are now often being transferred from paper to machine-readable form. This raises issues of storage on a medium for which the proper equipment or programs may not be available in later years. Another issue is that the storage of information chronologically on disks may eventually lead to unmanageable index sizes in order to provide access to the data.

- (2) For what period of time should information be preserved? Obviously, the range is great—from less than one day to forever. Different kinds of information fall into different categories, and agencies must develop policies according to their information types.
- (3) How should information be preserved? For medium- to long-term or archival storage, magnetic tape and optical disk are the two preferred media at this time. The latter is progressing out of the research and development stage, and emphasis is on mass production. Life expectancy of these media is still uncertain.

In this area, Federal Government policies are fragmented. NLM should be aware of activities at the national level to address these problems and should be prepared to participate in policy development.

Preservation of the Distributed Collection

While the preservation of NLM's own collection is a major step toward the preservation of the entire scholarly biomedical record, the Library also has a responsibility to assist in the preservation of important biomedical literature held by other U.S. institutions. NLM's preservation efforts are to be coordinated with those of other national, research, and biomedical libraries.

Much of the preservation problem can be stopped at its source if the scholarly record is published on archival media not predisposed to rapid deterioration. To lessen the need for preservation treatment of prospective publications, NLM should actively encourage the publishing industry to use more durable materials in the production of the biomedical literature.

Collection Management

Conversion of Format

The U.S. National Archives recommends copying magnetic tapes at least once every 6 to 10 years. Thus, while data stored on magnetic tape may not require conversion to another format, they do require periodic recopying in the same format. In addition, magnetic tape should be periodically rewound in the opposite direction from which it was last wound to avoid alteration of patterns on one layer by the magnetic fields of an adjacent layer.

Microcomputers have not yet provided for the compatible transfer of software from computer to computer. Libraries need to encourage the development of software compatible with a number of machines. Potential technologies such as holographic media should be examined as storage vehicles. NLM should plan to interact with the technologists developing these media to ensure that archival storage considerations are built into the design of new storage formats.

Organization of the Collection

In the discussions of Panel One, "organization of the collection" was interpreted to include all aspects of technical processing; cataloging and access to catalog records; indexing and the production of *Index Medicus*; research and the development of new methods in each of these areas; and the variety of cooperative efforts, such as the development of standards. The following paragraphs record the views of the Panel concerning the projected future with respect to each of these issues.

Index Medicus and MEDLARS

It is absolutely essential that NLM continue to publish *Index Medicus* and maintain the MEDLARS data bases and other indexes to key biomedical research and clinical reports. These tools are central to the organization not only of the NLM collection, but also to the operation of every medical library throughout the world. In fact, because of its international importance, NLM should continue to use cooperative arrangements with foreign countries to provide access to international publications.

The NLM Data Bases and the Changing Frontiers of Science

During the past two decades, the frontiers of medical science have undergone remarkable change. On one hand, they have extended deeply and more widely into the basic sciences; on the other, they have become increasingly concerned with integrative mechanisms and communication at all levels of organization. Moreover, as fundamental levels of science are drawn upon, distinctions between basic sciences have become increasingly blurred.

The combined data bases of NLM are comprehensive in their coverage of clinical medicine and the "traditional" basic sciences, but are less complete in new arenas, e.g., biochemistry, bioengineering, molecular biology, and genetics. Three solutions seem reasonable for this inevitable problem of keeping pace with changing directions and frontiers in medical science: (1) enlarge the scope of the data bases, (2) establish links with other data bases to complete the picture, or (3) employ a combination of those two.

If resources were unlimited, the scope of the NLM data bases could be broadened to include the new interests and horizons. The more likely scenario, however, is one of constrained growth in resources, so that some trimming of the current data bases will be required. Quite often, the same material is published in multiple journals with only slight change in form or content.

NLM should work with other producers of indexing publications and data bases in evaluating the means to share common data, while maintaining the value of subject-specific indexing. This may require research evaluating the scope of materials appropriate to such sharing, the degree to which specificity in indexing is necessary, and the means for sharing data and supplementing it to meet the needs of the individual publisher.

The Scope of MEDLARS

Another aspect of this problem is the definition of the boundaries that will encompass the NLM data bases. At first, the blurred boundaries between medicine, basic sciences, and related sciences may appear difficult to distinguish. But with the aid of professional societies in the basic sciences, citation indexes, bibliographies in journals devoted to clinical research, and clinical and basic scientists, limits could be defined for contemporary and foreseeable future needs in science.

A good deal of the discussion, therefore, was concerned with coverage in the MEDLARS data bases. Currently, although there are criteria for selection of journals for inclusion in MEDLARS and its various component data bases, the journals in general have been selected for indexing largely by informal methods: *ad hoc* judgments, opinions of consultants, and recommendations by subject and geographical

experts. The extent of the overlap of MEDLARS with other data base systems has also been determined not by formal criteria, but by the results of the MEDLARS selection process. NLM should apply bibliometric methods, including citation analysis, for both selection of serials and periodic assessment of current scope. Such formal methods might help to ensure bias-free selection, adequate representation of currently important and new subject areas, and appropriate classification or stratification of serials for particular search needs. The use of formal methods such as bibliometrics need not exclude additional selection methods, such as *ad hoc* judgments in new subject areas and selection by formal, publicly stated criteria.

Coverage of Electronic Publications

The Panel considered the question of NLM policy with respect to inclusion of electronic journals in their indexing process. Although no procedures exist for handling that question, in principle, NLM should consider a policy based on the requirement that, to be indexed, material must be available in archival form to assure continued availability and guarantee integrity of access. The acquisition requirements apply with equal force to the indexing of such materials; they should be covered by *Index Medicus* only if they are publicly available.

Ready Access of NLM Users to Other Data Bases

In an ideal world, NLM should provide a universal index of the scientific literature that relates to medicine. In actuality, the current expense would be prohibitive and the projected costs of keeping up with new frontiers in medicine are mind boggling.

As a reasonable alternative, NLM could take the lead in making other data bases available to its users and in establishing links with collections of needed materials that fall beyond its purview. At present, individual data bases collect data in their own styles and do not provide data in identical or similar ways; this discordance complicates the search and renders it more costly. As an example, a link might be established with other data bases in the following sequence:

- Define coverage;
- Specify tags for unique citations in each data base;
- Develop an automatic switch between data bases; and
- Create linkages between MeSH and other indexing systems that would allow a search originating in each data base to be automatically translated into an appropriate search of the other—with the option of searching only the unique citations.

An alternate and more formidable approach would be a master synthesis of available information that would reflect the state of current knowledge. This synthesis might take the form of a series of hypotheses or questions of causal statements. Each could be accompanied by references to relevant data and by indications of where pertinent data are unavailable. New data would be continually inserted into this synthesis so that the current state of knowledge would always be immediately up to date and at hand. Although implementing this approach would take many years, work on individual topics such as AIDS and congenital heart disease could be started now.

Obviously, temporary expedients should be avoided. The scientific bases for medicine will continue to expand, and attempts to grapple with its growth require a long and broad perspective.

Linkages Among Indexing Vocabularies

As a first step, however, NLM should continue cooperating with the Library of Congress to develop links between MeSH and LCSH (Library of Congress Subject Headings). The resulting information should be made available to other libraries so that catalog records including either LCSH or MeSH can be readily searched in the same online catalog. Then, users conducting subject searches can use whichever headings they find convenient and still retrieve all pertinent records, however they may have been assigned subject headings. Similar arrangements with relevant indexing and abstracting agencies could lead to the development of the cross-linkages that would make it feasible for NLM truly to become a switching center for access to all relevant literature.

Technical Support Systems

The Panel endorses NLM's efforts toward implementation of an integrated, automated system for technical support in acquisitions, serials control, cataloging, and indexing. Information in this system will form the basis for NLM's online public catalog and for enhancing access to materials in the NLM collection. Beyond those benefits to the ultimate user, this system will serve to improve the efficiency of NLM's technical services operations.

Standard Tools for Cataloging, Indexing, and Classification

The Panel applauds NLM's past efforts to establish tools for cataloging its collection that now represent the internationally accepted standards—MeSH and the National Library of Medicine Classification Scheme. It is essential for the operations of NLM itself, and the national and international biomedical library communities, that NLM continue to maintain these tools as the basis for subject access and logical organization of materials. They provide the rationale for the structure of the NLM catalog and the means for access to the collection; they are essential tools in technical processing; and they provide other health sciences libraries with authoritative data.

As an important creator of data for the national bibliographic system, NLM should continue to cooperate with other research libraries in the development of standards for bibliographic description. That would include, in particular, continued participation in national programs such as CONSER (Conversion of Serials), CIP (Cataloging in Publication), NACO (Name Authority Cooperation), and the Linked Systems Project. These efforts are intended to make descriptive cataloging data compatible among the major cataloging agencies, so as to ensure easy exchange of data, provide users with standard points of access regardless of the source of the data, and reduce duplication of effort through sharing of data. Of special importance is the effort in NACO to build a consistent name authority file that will link together works written by the same body regardless of the form of its name.



Extensions to Cataloging Practice

Regardless of the form of material, it must be placed under bibliographic control, whether hard copy, microform, or machine-readable form, and regardless of whether one is providing access to a citation that represents an item on a shelf or providing access to the content of an item in electronic form. Bibliographic control is the function that provides access by author, title, subject, or other criteria to the document itself or information in it.

NLM should provide leadership in the investigation of additions to the cataloging records that will provide more detailed descriptions of content. Data derived from the text, such as tables of contents, legends from illustrations and tables, and similar structural elements can serve as the basis for selection and for assuring greater specificity in the portions of materials requested and presented.

To further develop this approach, NLM should investigate the feasibility of augmenting the indexing of scientific articles with factual and graphic information derived from such sources as tables, graphs, and formulas. This may lead to the creation of "structured abstracts" that provide ways to identify key content elements of publications, regardless of their format.

In cooperation with the Library of Congress, NLM should participate in the development of formal tools to support cataloging decisions. These may take the form of "expert systems" that embody heuristics for good practice and draw on data bases, authorities, and algorithmic rules. They will provide the means to assure greater uniformity in cataloging and more effective interchange of data.

Expert systems will not replace bibliographic control, but should be investigated as a possible technique to assist in cataloging, which is the function that provides bibliographic control. To reduce the cost of this, the national libraries have already begun to explore the applicability of expert systems to cataloging. This investigation should continue into the future.

Standardization of Medical Records

Every hospital, clinic, and physician's office around the country contains records documenting the care and treatment of patients. These records have some degree of uniformity, principally because of the requirements for payment by Medicare and Medicaid or those of some accrediting body. But the lack of uniformity in the design of these records and in the medical language used in them combines with the sheer volume to make these data elusive and often irretrievable, despite their potential value for research.

Even now, private sector groups are defining standards and formats for record maintenance and transmission in such fields as clinical chemistry. There appears to be some risk that such standards may solve the need for unified formats and styles in particular fields, but lead to a chaos in communication. Standards for data content and machine-readable format are especially needed for patient records; and if these records are encoded in a variety of ways, it will be extremely difficult to merge or share them. It is not clear that leading such developments into a coherent standardization is part of the Library's mission, but at the least the Library might consider helping to bring together a coalition to tackle the problems.

Two research agendas are imperative for NLM to open up this wealth of information: (1) continue research with development of a Unified Medical Language System, and (2) work closely with Federal agencies to encourage report designs that ultimately would allow retrieval not only of financially related data items from the patient record, but also clinically related data that might be used in a research data base.

In working toward the goal of a reasonable data base, NLM must evaluate its role in collecting patient record data and/or providing bibliographic or other access to sets or subsets of such data.

Unified Medical Language System

NLM is supporting planning and research efforts to integrate access to disparate data bases that contain clinical patient data, biomedical research findings, references and text from published literature, and billing or other administrative records. Providing unified access to this variety of data bases requires development of means to map the vocabularies used in them. To this end, NLM has established the creation of a Unified Medical Language System as a priority program.

The Unified Medical Language System would include dictionaries and thesauri, cross indexes among them, automated tools for indexing and classification, computer programs to process records and evaluate their conformance with standards, and programs to update and maintain these files.

The plan is to include cooperative efforts with NIH, the American Medical Association and other professional societies, university investigators, and other agencies.

The Panel heartily endorses this development. NLM should vigorously pursue the development of the concept of a Unified Medical Language and, as appropriate, apply the results of that research to its own cataloging and indexing activities. The Panel's discussion identified several areas of value: linking patient data with scientific data, increasing the ability of practitioner to use the literature, improving the efficiency of searching, facilitating application of computer methods in medicine, and linking different kinds of information sources.

Public Access Catalogs

NLM should continue the development of an online public access catalog with a user-friendly interface, supplemented by microform or CD-ROM backup. This is a vital component in public service whose value has been clearly documented in all libraries where it is available.

Use of Electronic Manuscripts

NLM should continue its participation in cooperative programs with publishers designed to speed access to information (e.g., Cataloging in Publication, the Electronic Manuscript Project of the Association of American Publishers, and other opportunities as they may arise). This should include negotiation for the rights to extract suitable elements from electronic manuscripts as the basis for creating indexing records for access to them.

In cooperation with the Library of Congress, the publishers, the abstracting and indexing community, and others, NLM should promote further investigation of the relative merits of full-text retrieval versus use of a controlled vocabulary. The increasing availability of full text in machine-readable form makes it feasible to consider text-based retrieval.

Aside from the formal published literature, which has been the traditional focus of both collecting and indexing by NLM, other forms of information are of evident value and importance. Two specifically were considered by Panel One: patient records and numerical data bases. Aside from the problems inherent in such issues as confidentiality and accessibility, these forms of data pose special organizational problems.

The Panel considers it important that NLM play a proper role in dealing with these problems, but that it do so in cooperation with other agencies and focus its attention on those issues clearly within its scope. Its activities might include assisting in the development of indexing protocols to provide uniform access to patient records, maintaining a referral system to the sources for access to such data, and investigating means for indexing and cataloging textual and numerical data bases not included within the scope of widely distributed publications.

Research Into New Methods of Developing Critical Reviews and Synopses

With the still-widening scope and growing size of the journal literature relevant to medicine and the other health science fields and the likely growth of new types of "literature" in the form of computer-maintained data bases, the need for synoptic and integrative digestion of the literature will surely become an ever more pressing need. In recent years, the need has mostly been filled by review articles written by people. Judged by citation data, these reviews become the most heavily used kinds of journal papers, on average.

But preparing reviews is time consuming and calls for heavy commitments by relatively small numbers of subject experts. Machine (computer) or semi-automated methods for the digestion and integration of the critically important content of individual papers might facilitate access to a larger fraction of journal literature than many present users of *Index Medicus* can now manage. Such methods might involve innovations in text analysis, as well as in text structuring and marking for journal publication. NLM should consider developing research into such innovative methods and stimulating it through extramural grants.

As part of research into machine-run methods of subject synthesis, NLM should consider applying bibliometric methods, notably co-citation and citation analyses, to identify early the emergence of new subject fields of importance to the various health science disciplines. Such an approach might usefully supplement the present *ad hoc* methods that lead to special subject bibliographies of the kind currently produced by NLM.

Index to Availability of Expert Systems

It is recommended that NLM provide an online index to available biomedical expert systems. Such an index would include a unit record for each system, which would provide standardized descriptive information about the system (e.g., subject scope, system producer, subscription information, search software used, audience level, etc.); a descriptive abstract of the content of the system; and assigned subject headings.

The “expert system index” should be available for searching directly from NLM and other vendors interested in leasing the index from the Library. NLM should sponsor a meeting of expert system producers, librarians, and other appropriate individuals to define the information that should be included in the unit record. Results of this meeting should be publicized, and expert system producers should be encouraged to include such descriptive information as part of their expert system documentation.

Access to Information for the Patient

The patient is the ultimate beneficiary of research and clinical care. Until recently, most patients have not been aware of the research that preceded clinical diagnostic techniques or therapeutic regimes. Indeed, until the 1970’s, most patients had been nonpartners in their own health care, relying on their physicians to “make them well” despite poor follow-through on taking prescribed medications, performing routine exercises, and the like.

That model of leaving everything in the hands of the physician changed dramatically in the late 1970’s and 1980’s with renewed national and individual interest in health care and increased research in patient compliance with prescribed therapies. The new, evolving model places more responsibility for well-being and health care in the hands of the individual.

This trend can be accelerated when individual patients are directed toward the appropriate information resources to assist them in understanding the clinical problem, rationale for therapy, and importance of follow-through. Unfortunately, while more and more agencies are producing literature to assist in this process, biblio-

graphic access is virtually nonexistent. Health-care practitioners have no effective means of identifying relevant information to help patients deal with specific problems.

Direct education for patients, their families, and others in the general population would be a hopelessly large and costly function for the Library. However, NLM could meet such needs in part at a relatively low cost, either directly or indirectly through the RML system and its components. The system could provide some directories or gateways to information sources offered by agencies and special interest groups, such as NIH and foundations and coalitions oriented toward specific disorders or handicaps.

It is therefore recommended that NLM work to identify the appropriate body or bodies to provide some formal process of bibliographic access to this literature.

International Standards

NLM, with the Library of Congress, should promote a cooperative spirit among the international information resource agencies themselves. For many years, the Library of Congress, under the auspices of the CDNL (Conference of Directors of National Libraries), has been working with each country toward preservation and conservation of material. The Director of NLM was recently invited to participate in a CDNL meeting and is also kept informed of CDNL activities.

The proliferation of scientific information, together with the difficult worldwide economic conditions, makes the sharing of resources increasingly urgent. (As used here, resources include bibliographic citations, index entries, authority records, and the materials themselves.) Recent technological advances make this continuing requirement even more imperative. The

mini- and microcomputer systems available today are leading us toward decentralized processing and away from centralized processing. A nationwide network of networks appears to be evolving, which makes the requirement for standardization inescapable. In addition to the adoption of already existing standards, the advancing technology has created the need to develop and adopt new standards; for example, communication protocols and formats for electronic publishing.

NLM is the premier medical library in the world, and one of the national libraries of this country. Therefore, NLM has a responsibility to take a leadership role in standardization, nationally and internationally. Nationally, NLM should collaborate with other institutions in the medical field, e.g., medical schools and libraries, hospitals, and the medical publishing industry. The Library should also participate in the activities of the NISO (National Information Standards Organization), the agency responsible for U.S. information standards across disciplines.

Internationally, with the support of the United States medical information community, NLM should represent this community in such organizations as the ISO (International Standards Organizations) and IFLA, which are committed to developing and implementing standards for bibliographic control and information exchange.

A Unified Medical Language System would permit access to medical data bases without the requirement for exact terminology. NLM should serve as a focal point for the broad community of interest, evaluating feasibility, and supporting research.

Observations and Recommendations

Overall, Panel One recommends that NLM direct its efforts toward bringing together both present and emerging future technologies for information storage, accessing, transmission, and receiving to implement a comprehensive health sciences information system in the United States. This system, to be operational in the year 2006, would provide health science professionals with access to data bases, from NLM and elsewhere, easily and cheaply, from any location, through use of portable terminals. The goal should be a system that would provide immediate answers to vital questions and then guide users to further sources to meet nonimmediate needs. While building such a system should not be solely the responsibility of NLM, the Library can certainly take the leadership role under its Congressional mandate, stimulating its design and building in collaboration with publishers, technology providers, biomedical libraries, and health science institutions.

In its deliberations, the Panel looked toward specific programmatic elements that would contribute to this broad goal. Considering the Library's current programs and activities, the Panel identified components that should not only be continued, but strengthened. The Panel also identified initiatives that would add new components to the program and require additional resources. All of them derive directly from the discussion presented in the prior sections of this report.

The specific Recommendations from Panel One will therefore be presented in two parts:

- Endorsements of ongoing activities with recommendations for their continuation and enhancement;
- New initiatives.

General Recommendations

Considering current programs and activities, the Panel strongly believes that NLM should continue to:

- (1) Serve as the "library of record" for medicine and the health sciences generally, in recognition of the dependence of the entire U.S. biomedical library community on NLM as the "library of last resort."
- (2) Ensure the preservation of the core biomedical literature.
- (3) Publish *Index Medicus*, maintain the MEDLARS data bases, and provide online access to them. In fact, because of its international importance, NLM should continue to use cooperative arrangements with foreign countries to provide for access to international publications.
- (4) Develop and implement an integrated, automated system for technical support in acquisitions, serials control, cataloging, and indexing.
- (5) Develop and maintain intellectual tools, such as MeSH and the NLM Classification, for cataloging and indexing the biomedical literature.
- (6) Work cooperatively with other research libraries in the development of standards for bibliographic description.
- (7) Maintain and enhance its extensive and effective international programs. While the existing legislation has provided an adequate frame of reference for them in the past, NLM and the Board of Regents should consider whether there may need to be expansion and broadening of the NLM mandate and funding authority to include major new international responsibilities in the context of

advances in communications technology and medical informatics.

- (8) Provide its publications and services in traditional forms as well as newer forms.
- (9) Encourage the publication of articles that identify the contributions made by NLM to the advancement of medical research, practice, and librarianship.
- (10) Acquire informational materials of historical significance for its history of medicine collection in support of present and future scholarship, both in terms of the "history of medicine" as currently interpreted and in terms of providing the record of the present for future scholarship. In the future, nontraditional formats should be considered logical candidates for acquisition in this context.
- (11) Participate in cooperative programs with publishers designed to speed access to information (e.g., Cataloging in Publication, the Electronic Manuscript Project of the Association of American Publishers, and other opportunities as they may arise). This participation should include negotiating for the rights to extract suitable elements from electronic manuscripts as the basis for creating indexing records for access to them.
- (12) Strengthen its coverage of materials needed to support the ancillary health-related professions.

New Initiatives

The Mission of NLM

- (13) NLM should institute new programs aimed at the educational development of the profession of medical librarianship. For many years, NLM was the place where a generation of medical librarians gained their experience and commitment. Under the aegis of the MLA Act, NLM supported educational programs designed to educate medical librarians, provide internship experiences for them, and develop medical information systems analysts and researchers in medical informatics. New initiatives are needed to deal with the necessary advances in the field of medical librarianship and informatics.

The Collection

- (14) NLM should strengthen the RML Program so that it can take advantage of the new electronic environment to improve the existing cooperative network of biomedical libraries.
- (15) NLM should establish collection policies that include acquisition of materials in the full range of media—print, film, and electronic.
- (16) NLM should take the lead in defining the problems raised by electronic publishing and working toward their resolution, in collaboration with publishers and technical experts. Specific issues that NLM must address in cooperation with other interested groups include:
 - assuring the future availability of material published in electronic form;
 - developing standards for electronic media that will assist NLM in carrying out its mission;

- establishing a coherent national policy regarding the preservation of raw data (text, numeric, and graphic) to replace the current fragmented approach of the U. S. Government;
 - imposing “bibliographic control” on the new formats and, most important, finding ways of guaranteeing “integrity of reference”—the audit trail that identifies where information was obtained and permits the precise reconstruction of the information at the time it was obtained.
- (17) NLM should *not* take responsibility for acquisition of such unpublished material as patient records. These materials are of widely varying accuracy, significance, and quality.
- (18) NLM should vigorously follow the recently developed preservation plan of NLM as set forth in *Preservation of the Biomedical Literature: A Plan for the National Library of Medicine* in accordance with the terms of the NLM Act and the clearly expressed intent of Congress. Important aspects of this plan are:
- a fundamental responsibility to preserve permanently books, periodicals, and other library materials pertinent to medicine, based on the guidelines in the *Collection Development Manual of the National Library of Medicine*;
 - periodic review of the plan with special reference to the need to keep it current with changes in media, especially the electronic media;
 - active encouragement of the publishing industry to use more permanent materials in the production of biomedical literature;
 - continued research in NLM’s Lister Hill Center on the preservation characteristics of new storage media, such as the optical disk formats in the prototype EDSR system and interaction with technologists developing these media to ensure that archival storage considerations are built into the new formats;
 - development of a National Preservation Program for the Biomedical Literature in conjunction with the RML Network and other library groups to address important biomedical literature held in other library collections.
- (19) NLM, in cooperation with the RML Network, should develop a program to identify, select, and collect the intellectual records of the leaders in medical research and practice.

Organization of the Collection

- (20) NLM should work with other producers of indexing publications and data bases in evaluating the means to share common data while maintaining the value of subject-specific indexing.
- (21) NLM should take the lead to make other catalog, index, and abstract data bases more readily available to its users by establishing gateway linkages to relevant information resources. The development of such cross-linkages will make it feasible for NLM to become a switching center for access to all relevant literature. It will be necessary to link the MeSH with the vocabularies used in other systems.

- (22) NLM should undertake and/or sponsor research on formal methods both for selection of serials to be indexed and for periodic assessment of current scope—such as the application of bibliometric methods, including citation analysis.
- (23) NLM should investigate the feasibility of augmenting cataloging and indexing records to provide more detailed information about content. By incorporating data derived from tables of contents, tables, graphs, formulas, and the like, NLM may be able to improve the users' ability to retrieve information specifically related to their information needs.
- (24) NLM should sponsor research on the creation of "structured abstracts" that provide means to identify key content elements of publications, regardless of format.
- (25) NLM should, in cooperation with the Library of Congress, the National Agricultural Library, and other interested groups, participate in the development of formal tools to support cataloging decisions.
- (26) NLM should establish a new research agenda in close cooperation with other Federal agencies to encourage standards and designs for medical records and reports that ultimately would allow retrieval not only of financially related data items from the patient record but clinically related data that might be used as a research data base.
- (27) NLM should vigorously pursue the development of the concept of a Unified Medical Language System and, as appropriate, apply the results of that research to the cataloging and indexing activities of the Library. This development in particular should be carried out in cooperation with other interested agencies.
- (28) NLM should, in cooperation with other agencies, promote further investigation of the relative merits of full-text retrieval versus the use of a controlled vocabulary. The increasing availability of full text in machine-readable form makes it feasible to consider text-based retrieval.
- (29) NLM should encourage research on machine (computer) or semi-automated methods for the digestion and integration of the critically important content of individual papers.
- (30) NLM should, as part of research into machine-run methods of subject synthesis, consider applying formal methods—such as co-citation and citation analyses—to identify early the emergence of new subject fields of importance to the various health science disciplines.
- (31) NLM should provide an online index to available biomedical expert systems.
- (32) NLM should collaborate with other U.S. information agencies involved in the medical field, as well as with the general library, information science, and publishing communities to develop U.S. and international standards for preservation, bibliographic control, and information interchange.
- (33) NLM should establish a policy based on the requirement that, to be indexed, material must be available in archival form in order to assure continued future availability and guarantee integrity of access.

- (34) NLM should work to identify the appropriate body or bodies to provide some formal mechanism for improved access to the wealth of patient-related literature. While the acquisition of such data is beyond the scope appropriate to NLM, there is a real need to establish means for access to it, and NLM is in the position to provide the necessary leadership.

The Users

- (35) NLM should encourage and support studies of the users of its services.

Special Opportunities

In the technological environment, where change is rampant, unpredictable, and profoundly unsettling, an effective strategic plan must provide the capacity to capitalize on unexpected windows of opportunity that offer immediate and transitory possibilities for effective action. In many instances, the ability to respond quickly to such opportunities will provide extraordinary benefits in the long term. Following are some current possible opportunities.

Archival Copies of Electronic Formats

Archival procedures for electronic formats have yet to be developed. Indeed, it is still too early to speculate on the predictable life cycles of such formats. It is doubtful that electronic publications will be preserved upon their demise since, unlike printed publications, the format does not lend itself to survival upon abandonment by the publisher. NLM has a window of opportunity to serve a crucial function by developing procedures for ensuring the preservation of materials in electronic format, with special concern for the time when they are no longer available from the publisher.

With biomedical electronic publication in an embryonic stage, NLM is in an excellent position to develop guidelines and procedures to ensure the availability of archival copies of such publications. In particular, NLM, prior to subscribing to an electronic publication, should obtain reasonable assurance that the publication will be preserved by the publisher or, instead, that the Library will be allowed itself to download the publication for storage in its own collection. NLM should also consider a policy prohibiting its indexing of electronic publications until such assurances of archival preservation are obtained.

Electronic publishing is beginning, and the passage of another two years is likely to see initiation of well-based and substantial publications in considerable numbers. Now is the time to develop guidelines in consort with both the public and the private sectors. As electronic publications proliferate over the coming years, the opportunity to assure archival preservation may be soon lost. So the time for definition of formats and media for archival copies is now!

Standards for Patient Records

Although responsibility for patient records is viewed as outside the scope of NLM's collection policy, the Library has a window of opportunity to play a crucial role in working with the private sector to develop standardized formats and communications protocols for patient records. It is an unparalleled opportunity, since normal market forces work against standardization, but the entire medical profession would benefit from them.

Focused Collections of Landmark Papers

It is impossible for any library today to collect the mountains of paperwork comprising the intellectual work of individual scholars, researchers, and clinicians.

Nonetheless, it is possible to identify the seminal workers in the field and to move aggressively to collect their papers before they are dispersed and lost. NLM should develop a focused program to identify, select, and collect the intellectual records of the leaders in medical research and practice.

International Activities

Neither intellectual activity nor disease-carrying organisms recognize political jurisdictions. Effective medical services require convenient access to information on an international basis. NLM should be prepared to respond quickly and in a leadership role to opportunities on the international scene that enhance both American medicine and the medical activities of other countries.

Gateway Linkages

Continuing change in technological tools and research directions will require continuing vigilance for the development of gateway linkages to relevant information resources. Although NLM can no longer function as an autonomous, comprehensive source for medical literature, it must be in a position to respond to the changing needs of the field by providing appropriate gateways to other sources.

Communications Systems and Networks

The current NLM-supported Biomedical Communications Network is rapidly entering the electronic age. Two components of it, the RML Program and the IAIMS initiative, readily lend themselves to the development of true nationwide systems for the management and dissemination of biomedical information. At the institutional level, a local IAIMS network will provide library information, instructional and statistical systems, clinical and research data, and a myriad of other pertinent data bases. Given that, the exchange of information among institutions or between institutions and clinicians or researchers becomes totally feasible, provided the system is in place to do so.

The importance of compatible hardware, software, and networks cannot be overstated. It is imperative that an effective, invisible network for access to international sources of information be developed. The technological capacities exist, but they cannot be used effectively without the resolution of the policy and political issues. NLM could play a vital role in the development of the necessary standards on an international scale.

In both areas, the need for intercommunicability has become clear, and yet efforts so far seem to have been largely *ad hoc*, not comprehensive and prospective. Again, the time for integrative efforts, supported if not led by the Library, is now!

NLM should continue its encouragement of the RML and IAIMS developments to ensure that the possibility of an electronic biomedical communications network remains within reach over the next two decades.

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The immediate consensus of the Planning Panel, in a discussion of the responsibility of NLM with respect to the history of medicine, was hearty endorsement of continued major emphasis upon it. The following are paragraphs presenting the past and current status of that responsibility.

Early History

The vast historical collections now at NLM constitute a national treasure. Providing for the continuing support, nurture, and care of the collections in the coming decades is without question a national duty. From modest beginnings in the years after the Civil War, the historical collections have grown to nearly 500,000 printed works. Many scholarly publications, some of them now classics in the history of medicine, have been published with support from the Library, with use of its collection, or both. The collections are now used by scholars from all over the world, and the bibliographical aids are the standard sources throughout the scholarly world of history of the life sciences.

Recent History

The Library's HMD (History of Medicine Division) was formed in 1945. It currently houses all of the Library's materials printed before 1871, as well as prints, photographs, and manuscript collections. The active oral history project and collection of contemporary manuscript materials will provide vital sources for those who wish to write the history of medicine in the 20th century. In the summer of 1986, all books and journals published between 1871 and 1913 will be transferred to HMD. It is probably safe to predict that within a decade, virtually all pre-World War II materials will be primarily of historical interest. There are also still tens of thousands of uncataloged pamphlets and dissertations that need attention. They are an obvious treasure trove of materials, although difficult to access at present in a systematic way.

The essence of the collection task of HMD and NLM as a whole does not change. It is their job to conserve the past of medicine. While the process of this task may remain the same, the content of the collecting changes with the changes in interest and scholarship of the very broad field of medicine, as well as with the progress of medical and scientific knowledge. In 1800, botany was an integral part of medicine, and so materials relating to medical botany are properly a part of the history of medicine. In the 20th century, this is no longer the case. But what about the social sciences as they relate to medicine, or molecular biology and genetics? The Library's collection policy for HMD seems to take the needs of a changing field (of medicine generally) into proper consideration. The planning panels should stress the need to continue this policy. As the technology of communication progresses, the medical book will still be with us; for HMD, this will be particularly true.

As a part of its role in the preservation of our medical past, the Library has established a significant archive for manuscripts. As we approach the end of this century, it seems especially important to preserve some of the papers so vital to an understanding of the vast and complicated developments in what is now known as biomedicine. It will be useful to be able to study how this new knowledge came about. The Library should be encouraged to collect such manuscript materials and the concomitant oral histories in tandem with other institutions engaged in the same task. No single center can possibly manage more than a small fraction of the available material. A coordinated effort, especially among institutions in proximity to one another, should be encouraged.

Current Programs

NLM's own archive is an important topic. The archive should be encouraged to maintain a record of this very important period of transition and change in biomedical communications. No center is as likely to be able to provide the primary materials for describing what may well be one of the most revolutionary periods in the long history of the storage and transmission of medical knowledge.

NLM's bibliographic efforts in the history of medicine long predate the existence of HMD. Dr. Fielding Garrison, who worked in the old Surgeon General's Library for about three decades, compiled in the 1930's a major list of 17th- and 18th-century medical publications, and an extensive (100 printed pages) students' checklist of texts illustrating the history of medicine. A much earlier list led him in 1913 to publish his large textbook on the history of medicine. The fourth edition of this book appeared in 1929, is still in print, and is still the single most useful book of its type. The same is true of the Garrison-Morton *A Medical Bibliography*.

More recently, NLM has published an annual bibliography of the history of medicine, with convenient 5-year cumulations. HMD has also published very useful catalogs of its 16th-, 17th-, and 18th-century collections. All of these are standard reference works in libraries all over the world. Similarly, more recently still, scholars around the country have been using HISTLINE, the Library's online bibliographic data base of publications relating to the history of medicine and related sciences.

In the last two decades, NLM has supported and staffed a small but very fine program made possible by Public Law 480 funds. These funds have paid for the translation into English and printing of a number of classical books and memoirs in the history of medicine. This program should be continued through NLM's special Foreign Currency Program.

Future Directions

In addition to the obvious roles of preservation and dissemination of historical materials, one may postulate still another role for HMD—that of teaching. In the first place, HMD is in an excellent position to assist NLM as a whole in getting its message out to the larger public and particularly to its medical user clientele. HMD has considered producing historical teaching materials. Because it has one of the richest collections of visual remains of the history of medicine, it could conceivably play a significant role in teaching.

For the professional audience, historical materials could be widely used at meetings or in classrooms. To the public at large, HMD has a wonderful opportunity to explain what medicine is, as a profession in our society and as an ever more complex body of scientific knowledge, all illustrated by the use of its historical materials. There is probably no better way to introduce medicine, to explain what it is all about, than to do it from the point of view of its development over time.

A history of medicine and the life science study section has existed since the early 1960's. Initially as a regular NIH section, then as a special section for the last 15 or so years, it has worked smoothly and very closely with NLM's extramural staff. Many significant books and monographs have resulted from support provided in this way. It is alarming, therefore, to see the erosion of funds from this small but extremely vital program for the history of medicine. From 21 awards totaling \$356,525 in 1981, there has been a drastic cut indeed to 10 awards totaling merely \$194,859 in 1985. Probably nowhere in the expenditure of Government funds has so little money produced so much high-quality work. To allow this curve to continue its downward course would mean the potential loss to society of many scholars who simply would see all too clearly that their future would be very bleak. Can the richest country in the history of the world afford to lose such a resource?

Other activities formerly important to NLM's role in support of medical history were a small but vital number of fellowships and a few training programs. A number of senior scholars in the field are now at work because such earlier support was available. NLM has not sponsored any training support in the history of medicine since the very early 1970's.

Even during a time of shrinking resources, serious consideration should be given to again making available some pre- and postdoctoral fellowship funds. Since the early 1970's, an increasing number of well-trained historians have moved from their own field into the history of medicine. This has served to enrich the history of medicine remarkably by widening its horizons and increasing its sophistication. Similarly, we must encourage a small number of medically trained people to turn their attention to history. They may attempt to do some history without any support, but with some time spent in a center where active research and teaching is going on, those interested people, whether historians with little knowledge of medicine or physicians and medical scientists with little knowledge of history and historiographic methods, will benefit immensely. Even small amounts of money would represent a significant contribution to ensure the continuation of scholarship and teaching in this field.

For the future, two points deserve emphasis. The first and most urgent is that no further erosion should occur in what already is a small amount of money. It has achieved results of very high quality. At stake is far more than simply providing for the activity of a few scholars. An entire field needs to be nurtured, for the stake is the well-being of a far larger enterprise—the health field in general and ultimately American society.

Second, it is important to keep in mind that present budget policies and exigencies stem from the present scene. Conditions will change; policies will differ; and the NLM planning document, by definition, must take a long view. Thus, suggestions involving additional sums of money need no further justification within the long-term view of the world.

Appendix B: NLM Planning Process

In January, 1985 the Board of Regents of the National Library of Medicine resolved to develop a long-range plan to guide the Library in wisely using its human, physical, and financial resources to fulfill its mission. The Board recognized the need for a well-formulated plan because of rapidly evolving information technology, continued growth in the literature of biomedicine, and the need to make informed choices of intermediate objectives that would lead NLM toward its strategic, long-range goals. Not only would a good plan generate goals and checkpoints for management, actually a map of program directions, but it would also inform the various constituencies among the Library's users about the future it sought and could help to enlist their support in achieving that future.

At the Board's direction, a broadly based process was begun involving the participation of librarians, physicians, nurses, and other health professionals; biomedical scientists; computer scientists; and others whose interests are intertwined with the Library's. A total of 77 experts in various fields accepted invitations to serve on one of the five planning panels. Each panel addressed the future in one of the five domains that encompass NLM's current programs and activities. The domains, which provided the panels a framework for thinking about the future are:

1. Building and organizing the Library's collection
2. Locating and gaining access to medical and scientific literature
3. Obtaining factual information from data bases
4. Medical informatics
5. Assisting health professions education through information technology

The Library chose a planning model with three components. First, it incorporates a general, somewhat indistinct vision of the future 20 years from now in medicine, library and information science, and computer-communications technology. That environment cannot be forecast precisely, but we can speak of a "distant" goal. That goal is seen as a societal objective whose

attainment involves many organizations and agencies. NLM has a major role to play in achieving the goal and must plan its part. Second, while the 20-year goals are indistinct, there are opportunities for and impediments against achieving them. The opportunities and impediments can be more clearly envisioned because they appear to lie roughly 10 years away. Third, the specific steps that should be taken to remove the impediments and take advantage of the opportunities should be programmed for 3 to 5 years.

The planning process also involved participation within the Library. The Director provided his version of the future in the form of a "Scenario: 2005," which was distributed to panel members and Library staff. NLM staff prepared background documents that reported NLM achievements in the five domains, identified issues, and reviewed current planning. Senior NLM staff members also acted as resource persons to the planning panels.

At the end of the planning process, each panel formulated recommendations and priorities for future NLM programs and activities in the domain under its purview. The five panel reports were reviewed by the Board of Regents in June 1986. The Board then asked the NLM staff to analyze and reconcile their findings, eliminating any duplications and consolidating the recommendations. This synthesized plan is presented in this volume. Together with the planning panel reports, it represents the official Long-Range Plan of the Board of Regents of the National Library of Medicine.

Photographs were obtained from the several Bureaus, Institutes, and Divisions of the National Institutes of Health (including the Office of the Director, NIH, the Warren G. Magnuson Clinical Center, and the National Institute on Aging), the Uniformed Services University of the Health Sciences, the World Health Organization, and William A. Yasnoff, M.D., Ph. D..

